Visceral Adiposity is Associated with Persistently High and Less Variable Blood Pressure: The Dallas Heart Study

Yuichiro Yano, MD, PhD
Department of Preventive Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, US

Mentor: Ian J. Neeland, MD
Department of Internal Medicine, Division of Cardiology UT Southwestern Medical Center, Dallas, TX, US
Presenter Disclosure Information

Yuichiro Yano, MD, PhD
Department of Preventive Medicine,
Northwestern University Feinberg School of Medicine

Funding support provided by
American Heart Association
Background

- Most studies linking obesity with hypertension use a single office-BP “snapshot”.

- Out-of-office BP and BP variability are alternative BP phenotypes implicated in the pathogenesis of vascular disease and stroke.

- The association between obesity, particularly regional fat distribution, and out-of-office BP and BP variability are unknown.
Objectives

To determine the associations of regional fat distribution with:

**Short-term (within-visit) BP**
- Home BP levels and BP variability
- Office BP levels and BP variability

**Long-term (over all visits) BP**
- BP levels and BP variability
The Dallas Heart Study

- A multiethnic (blacks, whites, and Hispanics) population study, recruiting Dallas County residents ages 18 to 65 years.
- Between 2000 and 2002, 2,595 participants completed 3 visits (two in-home and one in-office) over 5 months.
- Five BP measurements at each visit, using an automated oscillometric device.
Exposure: Adiposity variable

Abdominal MRI

Body Composition

Visceral fat

Subcutaneous fat

L2 - L3 level

Dual-energy X-ray absorptiometry (DEXA)

Lower body subcutaneous fat

Outcome: BP level and BP variability

Visit 1 (1st in-home survey)
SBP, mmHg
110
115
120
125

Visit 2 (2nd in-home survey)
ΔH1
ΔH2
ΔH3
ΔH4

Visit 3 (in-office survey)

Mean SBP

Average real variability (ARV)=
(|ΔH1| + |ΔH2| + |ΔH3| + |ΔH4|) / 4

2.5 months
2.5 months
Statistical analyses

Multivariable-adjusted linear regression models.
## Baseline characteristics (n=2,595)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, years</strong></td>
<td>44±10</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>46%</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>32%</td>
</tr>
<tr>
<td>African American</td>
<td>48%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>17%</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>33%</td>
</tr>
<tr>
<td><strong>Type 2 diabetes mellitus</strong></td>
<td>10%</td>
</tr>
<tr>
<td><strong>Antihypertensive med use</strong></td>
<td>20%</td>
</tr>
</tbody>
</table>

Data are expressed as the means ± standard deviation or percentage.
## Adiposity variables (n=2,595)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass index, kg/m²</td>
<td>29±7</td>
</tr>
<tr>
<td>Visceral fat, kg</td>
<td>2.2±1.0</td>
</tr>
<tr>
<td>Retroperitoneal fat mass, kg</td>
<td>0.8±0.5</td>
</tr>
<tr>
<td>Intraperitoneal fat mass, kg</td>
<td>1.3±0.7</td>
</tr>
<tr>
<td>Subcutaneous fat, kg</td>
<td>4.9±3.0</td>
</tr>
<tr>
<td>Hepatic triglyceride, %</td>
<td>5.6±5.7</td>
</tr>
<tr>
<td>Lower body subcutaneous fat, kg</td>
<td>9.5±4.6</td>
</tr>
</tbody>
</table>

Data are expressed as the means ± standard deviation.
# Short- and long-term BP values (n=2,595)

<table>
<thead>
<tr>
<th></th>
<th>Short-term BP</th>
<th>Long-term BP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home</td>
<td>Office</td>
</tr>
<tr>
<td>Mean SBP, mmHg</td>
<td>125±18</td>
<td>127±18</td>
</tr>
<tr>
<td>Mean DBP, mmHg</td>
<td>78±10</td>
<td>79±10</td>
</tr>
<tr>
<td>$\text{ARV}_{SBP}$, mmHg</td>
<td>4±2</td>
<td>4±3</td>
</tr>
<tr>
<td>$\text{ARV}_{DBP}$, mmHg</td>
<td>3±2</td>
<td>3±2</td>
</tr>
</tbody>
</table>

Data are expressed as the means ± standard deviation.
## Adiposity variable – mean BP associations (n=2,595)

Each adiposity-related parameter was analyzed separately. Adjusted for age, sex, BMI, smoking, physical activity, fasting glucose, total cholesterol, HDL, use of antihypertensive drugs, prevalent diabetes and CVD. *P<0.05.

<table>
<thead>
<tr>
<th>Mean SBP</th>
<th>Short-term BP</th>
<th>Long-term BP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home SBP</td>
<td>Office SBP</td>
</tr>
<tr>
<td></td>
<td>β (SE)</td>
<td>β (SE)</td>
</tr>
<tr>
<td>Visceral fat, per 1kg</td>
<td>1.9 (0.5)*</td>
<td>2.7 (0.5)*</td>
</tr>
<tr>
<td>Subcutaneous fat, per 1kg</td>
<td>0.4 (0.2)</td>
<td>0.4 (0.2)</td>
</tr>
<tr>
<td>Hepatic triglyceride, per 1%</td>
<td>0.02 (0.1)</td>
<td>0.1 (0.1)</td>
</tr>
<tr>
<td>Lower body subcutaneous fat, per 1kg</td>
<td>-0.3 (0.1)*</td>
<td>-0.2 (0.1)</td>
</tr>
</tbody>
</table>
Adiposity variable – BP variability associations (n=2,595)

<table>
<thead>
<tr>
<th>ARV&lt;sub&gt;SBP&lt;/sub&gt;</th>
<th>Short-term BP</th>
<th>Long-term BP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home SBP</td>
<td>Office SBP</td>
</tr>
<tr>
<td>Visceral fat, per 1kg</td>
<td>0.1 (0.1)</td>
<td>0.1 (0.1)</td>
</tr>
<tr>
<td>Subcutaneous fat, per 1kg</td>
<td>0.01 (0.03)</td>
<td>0.04 (0.04)</td>
</tr>
<tr>
<td>Hepatic triglyceride, per 1%</td>
<td>-0.01 (0.01)</td>
<td>-0.01 (0.01)</td>
</tr>
<tr>
<td>Lower body subcutaneous fat, per 1kg</td>
<td>0.01 (0.02)</td>
<td>0.003 (0.02)</td>
</tr>
</tbody>
</table>

Each adiposity-related parameter was analyzed separately. Adjusted for age, sex, BMI, smoking, physical activity, fasting glucose, total cholesterol, HDL, use of antihypertensive drugs, prevalent diabetes and CVD. *P<0.05.
Summary

• Excess visceral fat is associated with **persistently higher** short- and long-term mean BP with **lower** long-term BP variability independent of BMI.

• Lower body subcutaneous fat is associated with lower short- and long-term mean BP.

• No association of abdominal subcutaneous or hepatic fat with BP phenotypes.
Conclusions and Implications

• Persistent BP elevation with less variability may explain increased risk for cardiac hypertrophy and failure seen with excess visceral fat.

• Further studies needed to determine whether modifying regional fat distribution may help improve hypertension prevention and treatment.
Acknowledgements

Study participants

University of Texas Southwestern Medical Center
Ian J. Neeland
James A. de Lemos
Colby Ayers
Wanpen Vongpatanasin
Aslan Turer
Alvin Chandra

Northwestern University
Philip Greenland
Mercedes Carnethon

The Dallas Heart Study was supported by a grant from the Reynolds Foundation and grant UL1TR001105 from the National Center for Advancing Translational Sciences of the National Institutes of Health.

This work is also supported by AHA SFRN grant and the National Center for Advancing Translational Sciences of the National Institutes of Health and by grant 1K23DK106520 from the NIDDK/NIH to Dr. Neeland.
Back up
BMI and VAT: Divergent ARV Phenotypes

Mean SBP over visits (mmHg)

Visit-to-visit ARV SBP (mmHg)

BMI (kg/m²)

Visceral Adipose Tissue (kg)
Additional Analyses

1. When VAT, SAT, and lower body fat analyzed jointly, associations of VAT and lower body fat remained significant.

2. We did not see heterogeneity of effect by sex or race.

3. Results were similar when antihypertensive medication use was excluded or when long-term ARV was defined using only the two home visits.
Outcome: BP levels and BP variability

Visit 1
(1st in-home survey)

Visit 2
(2nd in-home survey)

Visit 3
(in-office survey)

2.5 months

2.5 months

Mean home SBP

Within-home average real variability (ARV) =
(|ΔH1| + |ΔH2| + |ΔH3| + |ΔH4|) / 4

Within-office ARV =
(|ΔO1| + |ΔO2| + |ΔO3| + |ΔO4|) / 4

Within-visit home SD_{SBP}

Within-visit office SD_{SBP}

SBP, mmHg